SFP Bi-Directional Transceiver Module for Gigabit Ethernet

FEATURES

- **RoHS compliant**
- **Small Form-factor Pluggable (SFP) MSA compliant**
- **Simplex LC connector with 1310nm Transmitter and 1490nm Receiver**
- **Integrated with WDM filter to cut 1550nm and 1650nm optical signal off**
- **Single + 3.3V power supply and TTL logic interface**
- **Support Commercial and Industrial temperature range**
- **Bellcore GR-468 compliant**
- **Laser class 1 product which comply with the requirements of IEC 60825-1 and IEC 60825-2**

Description

The SPBD-1250xxxx series are hot pluggable 3.3V Small-Form-Factor (SFP) Bi-Directional transceiver module designed expressly for high-speed communication applications that require rates of up to 1250Mbit/sec. It is compliant with the Gigabit Ethernet standards, as well as the SFP Multisource Agreement (MSA).

The SPBD-1250xxxx transceivers provide with the LC receptacle that is compatible with the industry standard LC connector. The transceiver is also compatible with industry standard RFT connector and cage. It also includes a LOS (Loss Of Signal) circuit that provides a TTL logic-high output when an unusable optical signal level is detected.

The module includes un-cool FP laser, InGaAs PIN, Preamplifer and WDM filter in a high-integrated optical assembly for high-density system application. The SFP Bi-Directional transceiver can upgrade transmission capacity very convenient without installing new fibers.

Application

- IEEE 802.3ah 1000BASE-BX10
- Gigabit Ethernet Application
- FTTx WDM Broadband Access
- Switch to switch/backbone interface

Performance

- Data link up to 10km in 9/125um single mode fiber.

1. Absolute Maximum Ratings

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Storage Temperature	Ts	-40		85	ºC	
Storage Ambient Humidity	HA	5		95	%	
Power Supply Voltage	Vcc	-0.3		4	V	
Signal Input Voltage		-0.3		Vcc+0.3	V	
Receiver Damage Threshold		+3			dBm	

2. Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Operating Case Temperature (Commercial)	Tc	-5		75	ºC	Note (1,2)
Operating Case Temperature (Industrial)	Tc	-40		85	ºC	Note (1,2)
Ambient Humidity	HA	5		85	%	Non-condensing
Power Supply Voltage	Vcc	3.135	3.3	3.465	V	
Power Supply Current	Icc			300	mA	
Power Supply Noise Rejection				100	mVp-p	100Hz to 1MHz
Data Rate		1250 -100ppm	1250	1250 +100ppm	Mbps	
Coupled Fiber		Single Mode Fiber				ITU-T G.652
Transmission Distance				10	km	

Note (1). Measured on topside of case front center.

Note (2). Commercial temperature: SPBD-1250A4Q1R

Industrial temperature: SPBD-1250A4Q1RT

3. Specification of Transmitter

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Average Launched Power	P_O	-9	-6	-3	dBm	Note (1)
Optical Extinction Ratio	ER	6			dB	
Optical Modulation Amplitude	OMA	151 -8.2			uW dBm	
Center Wavelength	λ_C	1270	1310	1360	nm	FP Laser
Spectrum Width (RMS)	σ	Compliant with IEEE 802.3ah			nm	Note (4)
Transmitter OFF Output Power	P_{Off}			-45	dBm	
Optical Rise/Fall Time	t_r/t_f			260	ps	Note (2)
Deterministic Jitter	DJ			80	ps	
Total Jitter	TJ			227	ps	Note (3)
Relative Intensity Noise	$RIN_{12}OMA$			-113	dB/Hz	
Optical Return Loss Tolerance	ORLT			12	dB	
Transmitter Reflectance				-6	dB	
Output Eye Mask *{X1,X2,Y1,Y2,Y3}*	Compliant with IEEE 802.3ah standard *{0.22,0.375,0.20,0.20,0.30}*					Note (5)

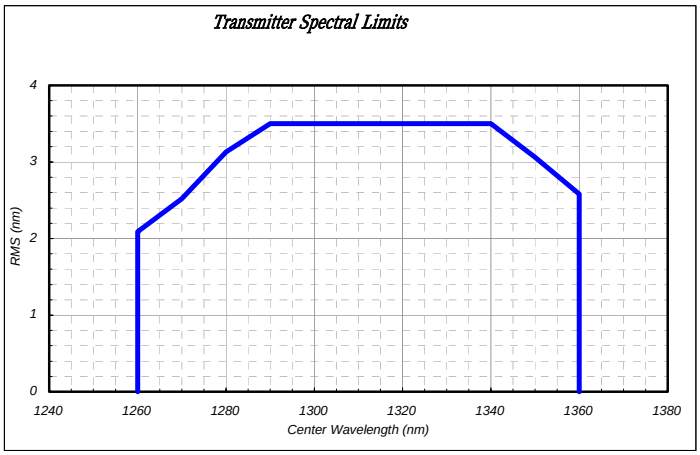
Note (1). Launched power (avg.) is power coupled into a single mode fiber.

Note (2). These are unfiltered 20-80% values.

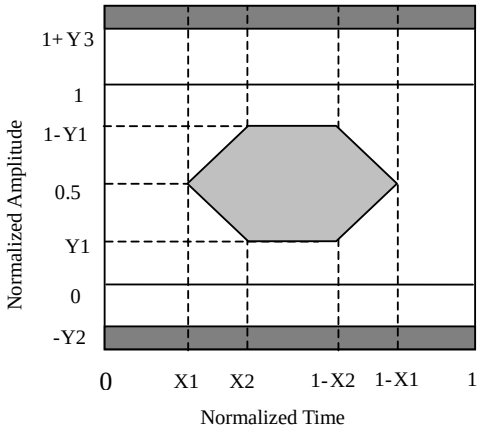
Note (3). Measure at 2^7-1 NRZ PRBS pattern.

Note (4): Spectral Width (RMS)

Center Wavelength	*RMS spectral width(max) 1000Base-BX10-U*
nm	*nm*
1260	*2.09*
1270	*2.52*
1280	*3.13*
1290	*3.50*
1295	
1297	
1329	
1331	
1340	
1350	*3.06*
1360	*2.58*



Note (5). Eye Mask definition



4. Specification of Receiver

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Input Optical Wavelength	λ_{IN}	1480	1490	1500	nm	PIN-PD
Receiver Sensitivity	P_{IN}			-20	dBm	Note (1)
Input Saturation Power (Overload)	P_{SAT}	-3			dBm	
Receive Sensitivity OMA	OMA	12 -19.2			uW dBm	
LOS-Deassert Power	P_A	-		-21	dBm	
LOS-Assert Power	P_D	-44			dBm	Note (2)
LOS Hysteresis	P_A-P_D	0.5	2	6	dB	
Receiver Reflectance				-12	dB	Note (3)
Deterministic Jitter	DJ			170	ps	
Total Jitter	TJ			266	ps	
Output Data Rise/Fall time	t_r/t_f			260	ps	Note (4)

Note (1). Measured with λ_{IN}, ER=6dB; BER =<10^{-12}@PRBS=2^7-1 NRZ

Note (2). When LOS asserted, the data output is Low-level (fixed)

Note (3). When the terminal is viewed from the optical path, the reflection toward the optical path of the optical signal with a central wavelength of λ_{IN} transmitted to terminal.

Note (4). These are 20%~80% values

5. Electrical Interface Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Transmitter						
Total Supply Current	I_{CC}			A	mA	Note (1)
Differential Data Input Swing	VDT	500		2400	mV_{p-p}	
Differential line input Impedance	R_{IN}	80	100	120	Ohm	
Transmitter Disable Input-High	V_{DISH}	2		V_{CC}	V	Note (2)
Transmitter Disable Input-Low	V_{DISL}	0		0.8	V	
Transmitter Fault Output-High	V_{TXFH}	2		V_{CC}+0.3	V	
Transmitter Fault Output-Low	V_{TXFL}	0		0.8	V	
Transmitter Fault Pull up Resistor	R_{TX_FAULT}	4.7		10	kΩ	Note (3)
Receiver						
Total Supply Current	I_{CC}			B	mA	Note (1)
Differential Data Output Swing	VDR	400		1200	mV_{p-p}	Note (4)
LOS Output Voltage-High	V_{LOSH}	2		V_{CC}+0.3	V	
LOS Output Voltage-Low	V_{LOSL}	0		0.8	V	
Receiver LOS Load	R_{RXLOS}	4.7		10	kΩ	Note (3)

Note (1). A (TX)+ B (RX) = 300mA

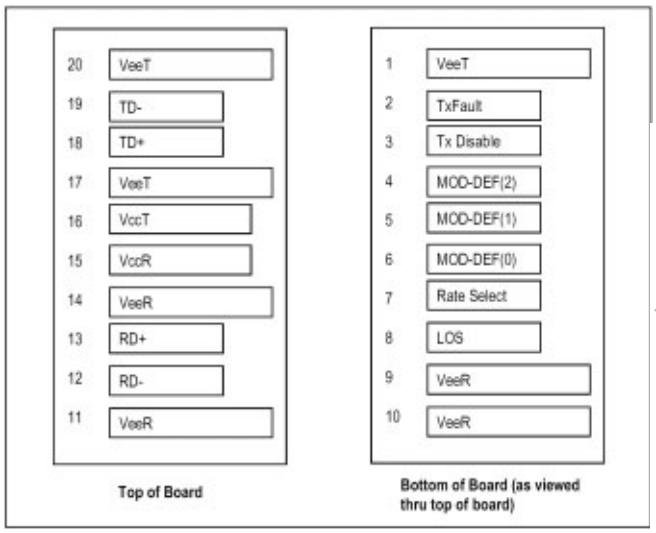
(A: Not include termination circuit; B: using a resister of 150Ω between Data-output and ground)

Note (2). There is an internal 4.7 to 10kΩ pull-up resistor to VccT.

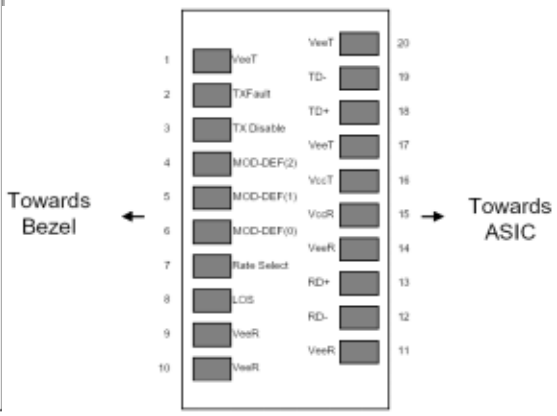
Note (3). Pull up to V_{CC} on host Board.

Note (4). Internally AC coupled with CML output, but requires a 100Ohm differential termination at or internal to Serializer/ Deserializer.

6. Pin Description



SFP Transceiver Electrical Pad Layout



Host Board Connector Pad Layout

Pin Function Definitions

Pin Num.	Name	Function	Plug Seq.	Notes
1	VeeT	Transmitter Ground	1	Note (1)
2	TX Fault	Transmitter Fault Indication	3	Note (2)
3	TX Disable	Transmitter Disable	3	Note (3)
4	MOD-DEF2	Module Definition 2	3	Note (4), 2 wire serial ID interface
5	MOD-DEF1	Module Definition 1	3	Note (4), 2 wire serial ID interface
6	MOD-DEF0	Module Definition 0	3	Note (4), Grounded in Module
7	Rate Select	Not Connect	3	Function not available
8	LOS	Loss of Signal	3	Note (5)
9	VeeR	Receiver Ground	1	
10	VeeR	Receiver Ground	1	
11	VeeR	Receiver Ground	1	
12	RD-	Inv. Received Data Out	3	Note (6)
13	RD+	Received Data Out	3	Note (6)
14	VeeR	Receiver Ground	1	
15	VccR	Receiver Power	2	Note (7)
16	VccT	Transmitter Power	2	Note (7)
17	VeeT	Transmitter Ground	1	
18	TD+	Transmit Data In	3	Note (8)
19	TD-	Inv. Transmit Data In	3	Note (8)
20	VeeT	Transmitter Ground	1	

Plug Seq.: Pin engagement sequence during hot plugging.

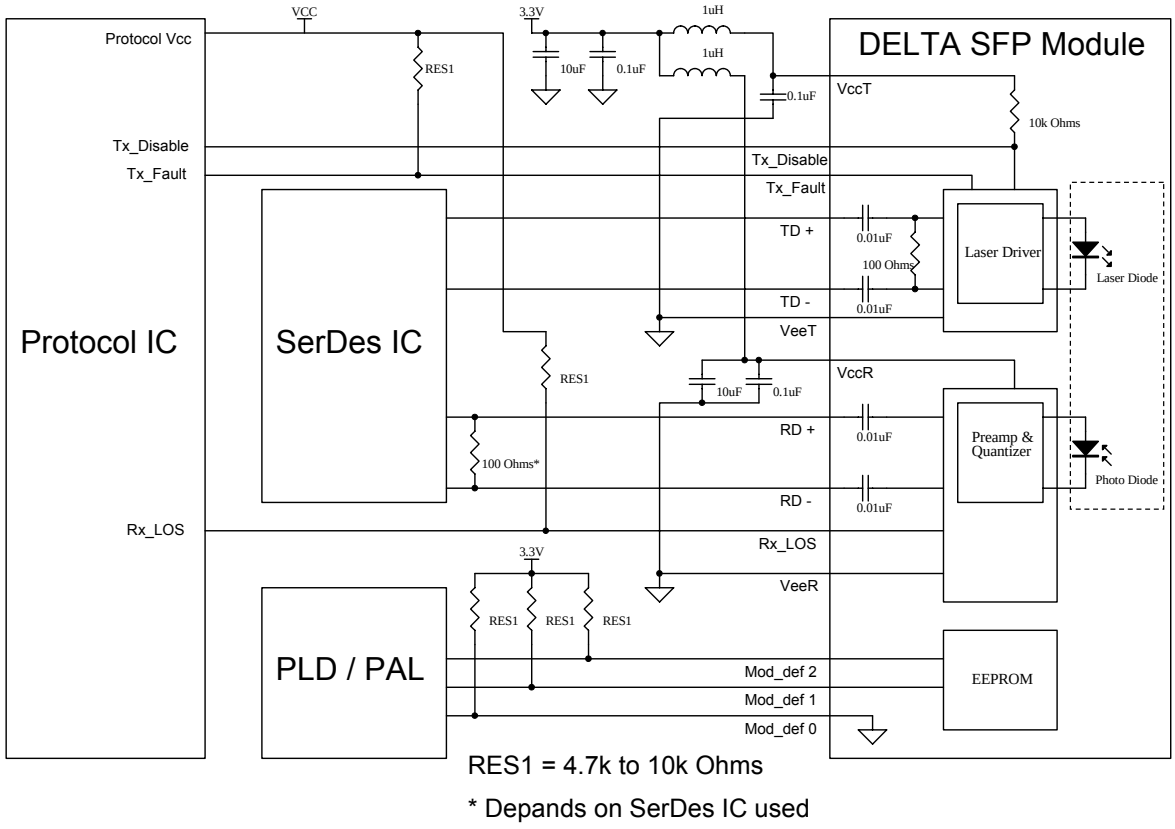
Notes:

1) Circuit ground is internally isolated from frame (chassis) ground. Tx GND and Rx GND may be internally isolated within the TRx module.
2) TX Fault is an open collector/drain output, which should be pulled up with a 4.7K~10KΩ resistor on the host board. Pull up voltage between 2.0V and VccT+0.3V. The output indicates Low when the transmitter is operating normally, and High with a laser fault including laser end-of-life. In the low state, the output will be pulled to less than 0.8V.
3) TX disable is an input that is used to shut down the transmitter optical output. It is pulled up within the module with a 4.7 – 10 K Ω resistor. Its states are:

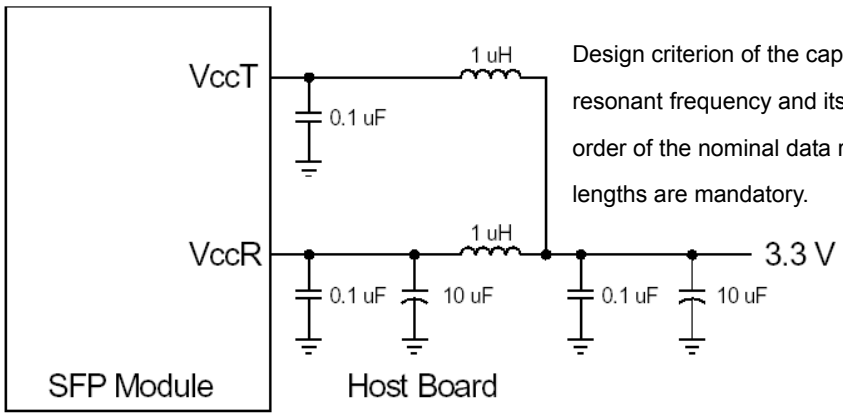
Low (0 – 0.8V):	Transmitter on
(>0.8, < 2.0V):	Undefined
High (2.0 – 3.465V):	Transmitter Disabled
Open:	Transmitter Disabled

4) Mod-Def 0,1,2. These are the module definition pins. They should be pulled up with a 4.7K – 10KΩresistor on the host board. The pull-up voltage shall be VccT or VccR.
   Mod-Def 0 is grounded by the module to indicate that the module is present
   Mod-Def 1 is the clock line of two-wire serial interface for serial ID
   Mod-Def 2 is the data line of two-wire serial interface for serial ID
5) LOS (Loss of Signal) is an open collector/drain output, which should be pulled up with a 4.7K – 10KΩ resistor. Pull up voltage between 2.0V and VccR+0.3V. When high, this output indicates the received optical power is below the worst-case receiver sensitivity. Low indicates normal operation. In the low state, the output will be pulled to less than 0.8V.
6) RD-/+: These are the differential receiver outputs. They are AC coupled 100Ω differential lines which should be terminated with 100Ω (differential) at the user SERDES. The AC coupling is done inside the module and is thus not required on the host board.
7) VccR and VccT are the receiver and transmitter power supplies. They are defined as 3.3V ±5% at the SFP connector pin. Recommended host board power supply filtering is shown below page. Inductors with DC resistance of less than 1 Ohm should be used in order to maintain the required voltage at the SFP input pin with 3.3V supply voltage. When the recommended supply-filtering network is used, hot plugging of the SFP transceiver module will result in an inrush current of no more than 30 mA greater than the steady state value.
8) TD-/+: These are the differential transmitter inputs. They are AC-coupled, differential lines with 100 Ω differential termination inside the module. The AC coupling is done inside the module and is thus not required on the host board. The inputs will accept differential swings of 500 – 2400 mV (250 – 1200 mV single-ended), though it is recommended that values between 500 and 1200 mV differential (250 – 600 mV single-ended) be used for best EMI performance.

7. Recommend Interface Circuit



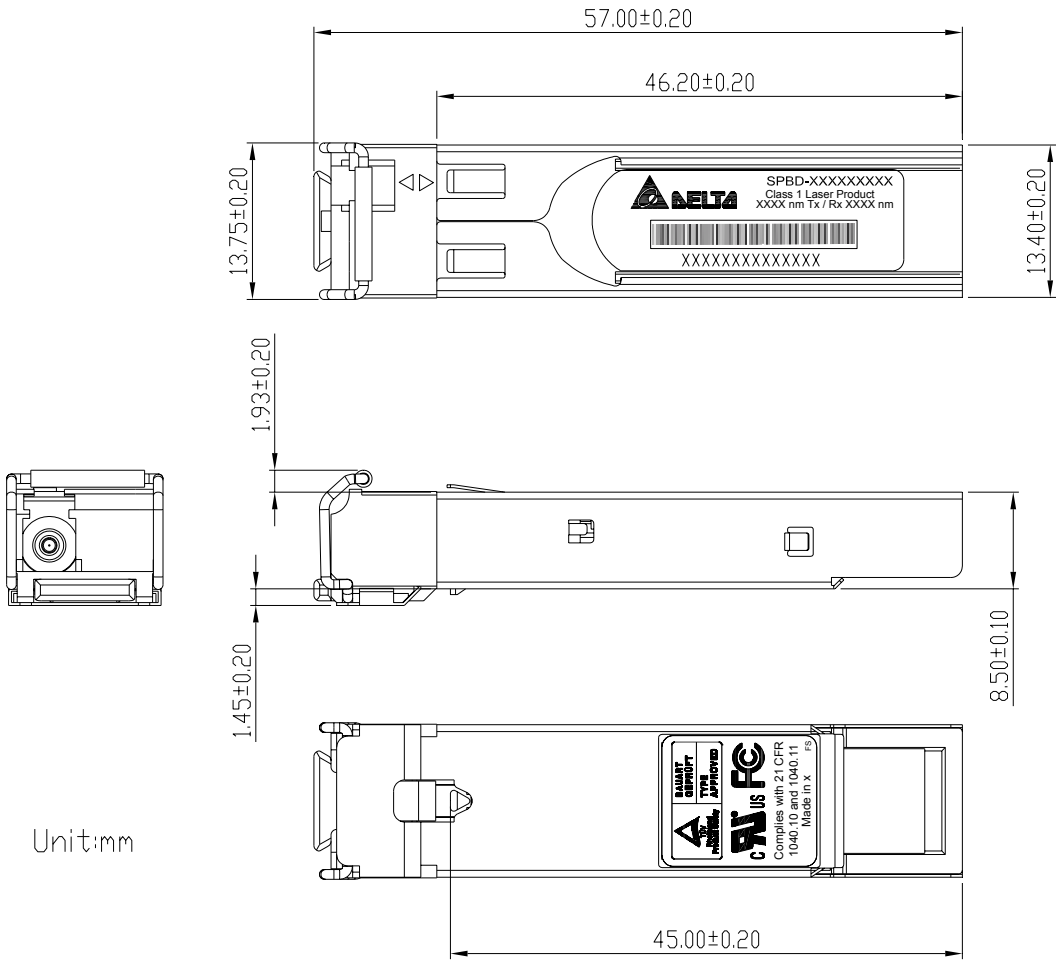
SFP Host Board Schematic

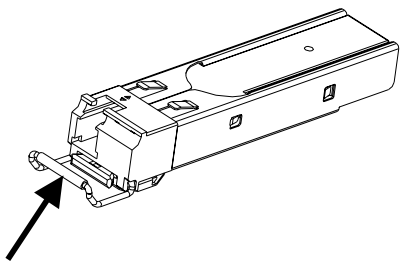


Design criterion of the capacitor used is the resonant frequency and its value must be in the order of the nominal data rate. Short trace lengths are mandatory.

Recommended Host Board Supply Filtering Network

8. Outline Dimensions



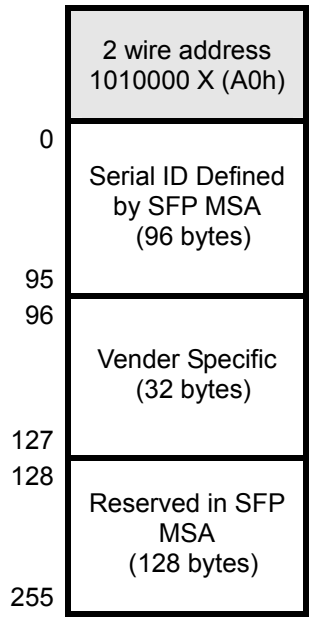


Transmitter Wavelength	Latch Color Identifier
1310nm	Blue
1490nm	Violet

9. EEPROM Serial ID Memory Contents (2-Wire Address A0h)

Address	Name of Field	Value (Hex)	Remark
Base ID Fields			
00	Identifier	03	SFP transceiver
01	Ext. Identifier	04	Serial ID module supported
02	Connector	07	LC connector
03		00	Infiniband Compliance Codes
04-05	Transceiver code	00 00	Transceiver codes
06	Transceiver code	40	Ethernet Base-BX10 compliance
07-10	Transceiver code	00 00 00 00	Transceiver codes
11	Encoding	01	Compatible with 8B10B GE encoding code
12	BR, Nominal	0D	Nominal 1300 Mbps (actual GE 1250Mbps)
13	Reserved	00	Reserved for SFF-8079
14		0A	9/125 ìm fiber, units of km (10km)
15		64	9/125 ìm fiber, units of 100 m (10000m)
16		00	50/125 ìm fiber, units of 10 m
17		00	62.5/125 ìm fiber, units of 10 m
18		00	Link length supported for copper, units of meters
19		00	Reserved
20	Vendor Name	44	“D” (Vendor name in ASCII character)
21		45	“E” (Vendor name in ASCII character)
22		4C	“L” (Vendor name in ASCII character)
23		54	“T” (Vendor name in ASCII character)
24		41	“A” (Vendor name in ASCII character)
25-35		20	(Vendor name in ASCII character)
36	Channel spacing	00	Specify the channel spacing in units of GHz.
37-39	Vendor OUI	00	SFP vendor IEEE company ID
40	Vendor P/N	53	“S” (Vendor P/N in ASCII character)
41		50	“P” (Vendor P/N in ASCII character)
42		42	“B” (Vendor P/N in ASCII character)
43		44	“D” (Vendor P/N in ASCII character)
44		2D	“-“ (Vendor P/N in ASCII character)
45		31	“1” (Vendor P/N in ASCII character)
46		32	“2” (Vendor P/N in ASCII character)
47		35	“5“ (Vendor P/N in ASCII character)
48		30	“0” (Vendor P/N in ASCII character)
49		41	“A” (Vendor P/N in ASCII character)
50		34	“4” (Vendor P/N in ASCII character)
51		51	“Q (Vendor P/N in ASCII character)
52		31	“1” (Vendor P/N in ASCII character)
53		52	“R” (Vendor P/N in ASCII character)
54		20 or 54	“ ” or “T” (Vendor P/N in ASCII character)
55		20	(Vendor P/N in ASCII character)
56-59	Vendor Rev	41 20 20 20	“A”
60-61	LD wavelength	05 1E	(1310nm) in Hex byte
62	DWDM wavelength	00	
63	CC_BASE	XX	Check sum (0~62)
Extended ID Fields			
64	Reserved	00	
65	Options	1A	(Tx_Diasble, Tx_Fault, LOS)
66	BR,max	00	Upper bit rate margin,units of %
67	BR,min	00	Lower bit rate margin,units of %
68-83	Vendor SN	XX	“DEYYWWVVRSSSSS”
84-91	Date code	XX	“YYMMDD”

92	DDM	00	
93	Enhanced options	00	
94	SFF-8472 compliance	01	SFF-8472 Compliance Rev.9.3
95	CC_EXT	XX	Check sum (64~94)
Vendor Specific ID Fields			
96-127	Vendor Specific	00	Vendor Specific EEPROM
128-255	Reserved	00	Reserved for SFF-8079



10. Regulatory Compliance

Feature	Test Method	Reference	Performance
Electrostatic Discharge (ESD) to the Electrical Pins	Human Body Model (HBM)	MIL-STD-883E Method 3015.7 EIA-JESD22-A114	(1) Satisfied with electrical characteristics of product spec. (2) No physical damage
	Machine Model (MM)	EIA-JESD22-A115	
Electrostatic Discharge (ESD) to the Simplex Receptacle	Contact Discharge	IEC/EN 61000-4-2	
	Air Discharge	IEC/EN 61000-4-2	
Radio Frequency Electromagnetic Field Immunity		IEC/EN 61000-4-3	
Electromagnetic Interference (EMI)		FCC Part 15 Class B EN 55022 Class B (CISPR 22A)	
Laser Eye Safety	FDA/CDRH TUV	FDA 21CFR 1040.10, 1040.11 IEC/EN 60825-1 IEC/EN 60825-2	CDRH File # 0420993 TUV Certificate # R50032471
Component Recognition	TUV UL/CSA	IEC/EN 60950 UL 60950	 UL File # E239394

Appendix A. Document Revision

Version No.	Date	Description
S0	2008-09-23	Preliminary datasheet